A Dynamic Model of Campaign Spending in Congressional Elections

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Abstract

In contrast to conventional studies on campaign finance, which focus on the aggregate effect of money on the vote, we propose a more general dynamic model based on temporally disaggregated data. The model is supported by the substantive understanding that at different stages of the campaign process candidates have different goals, and their expenditures should have different effects on the final election outcome. Using Achen's (1986) framework of quasi experiments, the model includes dynamic "assignment equations" and "outcome equations," which address the problem of nonrandom assignment. A final vote equation is derived in which the coefficients of period-specific incumbent expenditures are constrained by an Almon polynomial. Empirical estimation provides evidence for a three-stage dynamic campaign process.

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Introduction

As an important institution of representative democracy, elections are central to the study of Congress. The topic of money in congressional elections is particularly prominent since money affects the conditions of entry and reentry, rewards candidates possessing fund-raising ability, and penalizes those without. The "electoral connection" of money affects not only members' behavior and accountability but also the structure of Congress and, thus, public policy (Bailey 1990, 35–36).

Much of the existing research on money in elections focuses on the link between incumbents' electoral success and their monetary advantage-the ability to raise and spend large sums of money. The findings are mixed; many conclude that incumbent spending has little or no effect on the election outcome (Glantz, Abramowitz, and Burkart 1976; Jacobson 1978, 1990; Silberman and Yochum 1978; Feldman and Jondrow 1984; Ragsdale and Cook 1987; Abramowitz 1988, 1991; Kenny and McBurnett 1992), while others conclude that it has a considerable influence on the vote (Green and Krasno 1988, 1990; Stewart 1989; Thomas 1989; Ansolabehere 1990; Grier 1989; Green, Robins, and Krasno 1991; Erikson and Palfrey 1992). The disagreement is partially attributable to whether incumbent spending is considered endogenous in the campaign process.

Although the literature is extensive, almost all models use temporally aggregated data and thus assume that the effect of spending on the vote is constant over the election cycle.[1] We consider the possibility that the effect may change over time by utilizing a dynamic model based on temporally disaggregated data. Our model provides a test for our substantive understanding that at different stages of the campaign process expenditures made by incumbents have different effects on the final election outcome. Compared with traditional models, our dynamic model is not only more theoretically plausible but also more methodologically appropriate in addressing the controversies regarding the endogeneity of incumbent spending.

The article is divided into seven sections. The next section motivates the model specification by presenting the substantive understanding of the dynamic campaign process. This is followed by a discussion

[1] Krasno, Green, and Cowden (1994) provide a well-crafted analysis of the effect of previous receipts on later fund-raising using disaggregated contributions. In contrast, we focus on the effect of disaggregated expenditures on election outcomes. Kenny and McBurnett (1992) disaggregate large individual contributions ($500-1,000) over time for a single House district in 1984. After redefining spending as the lag of contributions, they conclude that challenger spending has an effect while incumbent spending does not.

of methodological issues cast in the framework of a quasi experiment, which illuminates the necessity of temporal disaggregation. The fourth and fifth sections, respectively, present the "outcome equations" and "assignment equations" of the dynamic model. Following a description of the temporally disaggregated monetary data, the results of empirical analyses are shown in the sixth section, which is followed by concluding observations.

Campaign Spending: How Much and When?

Ample anecdotal and journalistic accounts indicate that candidates, campaign strategists, and contributors pay attention to timing (Guzzetta 1981; FaithAmerica Foundation 1982; Beaudry and Schaeffer 1986). These accounts suggest that an incumbent's early expenditures have an especially strong, positive effect on the final vote. A well-known example is Emily's List, which stands for Early Money Is Like Yeast and involves an organizational effort to provide critical seed money to Democratic, pro-choice women running for office. The suspected importance of early money has been pointed out in campaign finance reform proposals as well.

In addition, academic literature suggests that timing is critical to electoral success (Aldrich 1980a; Goldenberg, Traugott, and Baumgartner 1986; Bartels 1988; Epstein and Zemsky 1992; Kessel 1992). In particular, studies have suggested a strong effect of early expenditures on the election outcome (Alexander 1972; Cheney 1980; Goldenberg and Traugott 1984; Malbin 1984; Bedlington and Powell 1986; Biersack and Wilcox 1990; Magleby and Nelson 1990) and later fund-raising success (Biersack, Herrnson and Wilcox 1993; Krasno, Green, and Cowden 1994). Nevertheless, the effect of the timing of expenditures has yet to be statistically tested in empirical analyses.

The timing of expenditures is expected to matter because candidates have different goals over the course of a campaign. Expenditures made at different stages are intended to accomplish the immediate goal pertaining to that stage. The literature on campaigns discusses the election cycle in terms of stages, but there are disagreements on how to define them, when they befall, and the degree of specificity (Salmore and Salmore 1989; Stewart 1989; Fritz and Morris 1992; Kessel 1992; Franklin 1993). Campaign strategy handbooks and the popular press often refer to the stages of a campaign as well (see, e.g., Beaudry and Schaeffer 1986; and Allis 1992).

Discussing the possible time-varying goals leads to a clearer descrip-

tion of the stages of a campaign.[2] We identify in the campaign process three goal-oriented stages characterized by, respectively, (1) organizational entrenchment after start-up, (2) securing a primary constituency, and (3) securing a reelection constituency.[3]

A constant effort throughout the election cycle, fund-raising is at the core of the first stage and is necessarily dependent on the internal campaign organization. The main purpose of expenditures at this stage is to produce more contributions through organizational efforts. Biersack, Herrnson, and Wilcox (1993) provide supporting empirical evidence. Contributions, in turn, fortify the organization in preparation for effective campaigning at the second and third stages.

As soon as the challenger makes the decision to run, organization building, which includes activities such as setting up an office, hiring staff, coordinating volunteers, and lining up financial contributors, begins. Challengers must effectively compress the time needed to build an internal campaign structure so that they can begin full-fledged efforts in fund-raising (Mann and Wolfinger 1980; Biersack, Herrnson, and Wilcox 1993). On the other hand, contributors want to see evidence about the challenger's probability of success, such as encouraging polling results or a successful direct mail campaign. In order to gather this type of evidence, substantial amounts of money are needed (Herrnson 1990). Thus, challengers are often in a catch-22 situation.

In contrast, incumbents, with all the advantage of name recognition, already have their "gold-plated permanent political machine" and can immediately begin raising money after the last election (Fritz and Morris 1992, 13). For the incumbent, organizational entrenchment is geared toward maintaining support among constituents and building "momentum" for fund-raising. Expenditures during the first stage are expected to be especially instrumental.

At the second stage, candidates focus on securing a primary constituency. Candidates are prospective planners throughout the campaign with the ultimate goal of winning the general election; however, the support of their party's loyalists has to be won first. The campaign agenda must be designed with two goals in mind: it must appeal to supporters within the party as well as the general electorate. Since the

[2] Our theoretical understanding is based on the academic literature, campaign strategy materials, and interviews with members of Congress, challengers, and party leaders.

[3] Fenno (1978) defines the primary constituency as the people "from whom he expects a special solidity of support in a primary election, "not all the people who vote for the congressperson in the primary" (18). The reelection constituency "is composed of those people in the district who he [the congressperson] thinks vote for him" (8).

median positions of the two groups are often different, the key to success is finding an agenda that ensures winning the support of their party's loyal voters and will optimize the probability of winning enough votes (perhaps by gathering the support of rival partisans) in the general election. Costantini and King (1982) and Jones and Miller (1985) point out that contributors are often more ideologically extreme than is the median voter. This fact enhances the dilemma of securing a primary and reelection constituency. The existence of strong opposition in a divisive primary would make it even more difficult to attain both goals.

Unlike agenda setting, expenditures at the second (primary election) stage are largely made toward the short-term goal of winning the support of their party's loyalists, who tend to also be contributors. Whether the opposition is weak or strong, it is always strategically important to turn out a significant number of supporters for the primary. Such drives are costly, and spending certainly increases with the strength of the opposition. As a consequence of the conflict between short- and long-term goals, incumbent spending in the second stage may have an inconsequential or even adverse effect on the general election outcome.

At the third and final (general election) stage, candidates concentrate on building a reelection constituency and conveying information to all voters in the context of interparty competition. Here the efforts to reach the public involve activities that are easily distinguishable from those at the second stage. Candidates now use media advertisements and high-profile public appearances to provide information rather than relatively personal or small-scale fund-raising events. It should be reiterated that the agenda set at the second stage, which is designed to attract money from their party's contributors, can be adjusted but not fundamentally changed (Kessel 1992, 76). Furthermore, as Kessel (1992) points out, there simply is no time during what he calls the "time's up" stage to do much more than carry out plans already made.

Expenditures at the third stage are targeted at urging favorably disposed potential voters to go to the polls and persuading undecided ones. Money is spent for the purchase of television and radio advertisements, bumper stickers, yard signs, and so on.[4] The effect of such expenditures

[4] Ideally, what the incumbent's expenditures purchased throughout the two-year campaign cycle would be examined to provide additional evidence that the hypothesized goals are correct. The preparation of such a data set is left for future research because it is an immense project and requires obtaining original FEC filings and attempting to determine exactly what the expenditures purchased. Fritz and Morris (1992), utilizing the large resources of the *Los Angeles Times* obtained such data but did not incorporate the date of the expenditure, which makes the data inadequate for our purposes. However, Goldenberg and Traugott's "Congressional Campaign Study, 1978" can be used to gain some insight on the problem. The Congressional

on the final vote outcome is expected to be positive.

Based on expectations for the three stages, the effect of expenditures throughout the election cycle should follow a time-varying curve.[5] Specifically, our understanding of campaign dynamics predicts a dip in the effect of spending during the second stage due to the conflicting nature of short- and long-term goals. If this substantive understanding is sound, then the traditional studies based on temporally aggregated data are misleading since the effect of spending on the vote changes over time. In the next section, we turn to methodological issues to further justify the necessity of temporal disaggregation.

The Nonrandom Assignment of Expenditures

In the traditional, temporally aggregated analysis of the effect of expenditures on the vote outcome, the most widely recognized problem is the endogeneity of incumbent spending as an explanatory variable. The argument is that incumbents spend more money as they become more vulnerable. Thus, incumbent spending is partially determined by the expected vote outcome. Depending on whether or not this argument is accepted, either two-stage least squares (2SLS) or ordinary least squares (OLS) estimation is used, and different results are found in support of different theories about the effect of money on the vote.

Jacobson's (1976, 1978, 1990) OLS results show that incumbent expenditures have no effect on the vote outcome. His explanation is that when weak incumbents face strong opposition "the marginal gains incumbents derive from campaign spending do not, on average, offset the marginal losses produced by the challenges to which the incumbents

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Campaign Study data set, which can be obtained from ICPSR, contains information on purchases from July 1978 to November 1978 and thus can be used to test that the third stage is correctly characterized. We expect that the majority of expenditures will be for radio and television advertising, bumper stickers, and yard signs. An increase in expenditures for staff is also likely (Maisel 1986; Fritz and Morris 1992). The extra staff is hired for the short term to help with the flurry of activity that normally occurs as the election approaches, such as manning telephones, coordinating and working with volunteers, and going door-to-door or to shopping centers to hand out campaign material.

The relative proportion of expenditures and the trends over the months from July to November confirm expectations about purchases made in the third period. The primary expenditure category is advertising, which constitutes 61 percent of total third-period expenditures. Payroll expenditures also increase in the third stage but not as do dramatically as advertising expenditures. The trends seen in the Goldenberg and Traugott data are consistent with the dates in figure 1, which is discussed later, and suggests that the third stage of a campaign may have lengthened slightly. That is, the third stage is beginning earlier relative to 1978.

[5] Additional insight into the stages of a campaign may be obtained from a dynamic game perspective. This is discussed further after presenting the empirical analysis.

are, in a graduated fashion, responding" (1990, 357). Green and Krasno (1988, 1990) insist on the endogeneity of incumbent spending and use the incumbent expenditures in the prior election cycle as an instrument in carrying out 2SLS estimation. Their results show that the effect of incumbent spending is strong. Jacobson is skeptical about the appropriateness of the instrument and questions the identification of the models in both his own (1980, 1985) 2SLS analyses and in Green and Krasno's (1988) research. Jacobson (1985, 1990) concludes that when his 2SLS results are interpretable, they are the same as the OLS results, and thus the simultaneity bias is small.

In clarifying the debate between Jacobson and Green and Krasno, Bartels (1991) points out that instrumental variables are usually "quasi" in that it is difficult to find instruments that are entirely uncorrelated with the disturbances of the regression in question. The choice of instruments thus involves a trade-off between consistency and efficiency. In the case of the effect of money on the vote, current incumbent spending is severely endogenous because contributions are heavily conditioned on the information about the relative standing of the candidates in the race. In contrast, prior incumbent spending is relatively exogenous since the prior vote outcome is known and is used as an explanatory variable in the vote equation. Bartels concludes that such relative exogeneity warrants the cost in terms of inefficiency relative to the OLS model.

The endogeneity of incumbent spending can be better understood, using Achen's (1986) terminology, as a problem of "nonrandom assignment" in quasi experiments. In this case, random assignment is impossible because of the fact that variation in incumbent spending is determined by interacting political actors, including candidates, contributors, and voters, rather than by the researcher. Thus, to study the effects of incumbent spending on the vote outcome, a researcher needs to analyze not only the "outcome equation" which relates the vote to incumbent spending, but also the "assignment equation" which relates incumbent spending to its determinants. Methodologically, the two equations are "triangular." However, if the disturbance terms of the two equations are correlated (that is, if the equations are nonrecursive), there will be a nonzero covariance between incumbent spending and the disturbance term in the outcome equation, rendering the OLS estimators inconsistent. Contemporaneous correlation could occur if the same unspecified factors are influencing both incumbent spending and the vote outcome. When this is the case, 2SLS is appropriate, and an instrumental variable has to replace incumbent spending in the outcome equation.[6]

[6] The 2SLS estimators are consistent and asymptotically normally distributed.

In the temporally aggregated analysis, the outcome equation for the incumbent vote is:

$$V = \beta_1 + \beta_2 V_0 + \beta_3 IE + \beta_4 CE + \beta_5 CPPO + \beta_6 P + u_o, \quad (1)$$

where V is the vote outcome (percentage) for the incumbent, V_0 is the vote for the incumbent in the previous election, IE is the incumbent's expenditures, CE is the challenger's expenditures,[7] CPPO is a dummy variable indicating whether or not the challenger has held prior political office,[8] and P is a dummy variable representing the incumbent's party. u_o is the disturbance term.

The assignment equation, that is, the process in which incumbents' expenditures are determined, is usually not explicitly specified in the literature. Since the expected vote outcome is considered to be a major determinant of the process, however, it is reasonable to formulate the assignment equation as

$$IE = \alpha_1 + \alpha_2 V_0 + \alpha_3 E(V) + \alpha_4 CE + \alpha_5 CPPO + \alpha_6 P + u_a, \quad (2)$$

where E(V) is the expected vote outcome and u_a is the disturbance term for this regression. Note that this system of equations is triangular. The endogeneity of IE will result in the inconsistency of the OLS estimates of the vote equation only if u_a and u_o are correlated. In practice, most researchers do not make efforts to measure E(V), for example, by opinion polls. Consequently, the assignment equation is not estimated, making it impossible to conduct a significance test for the correlation between u_a and u_o. Instead, the correlation between u_a and u_o, and hence between IE and u_o, is *assumed* to be nonzero, and 2SLS is carried out. In purging the correlation, the incumbents' expenditures in the previous election cycle are used, together with other exogenous variables in the system, to create an instrumental variable for IE in the outcome equation.

3SLS is asymptotically more efficient than 2SLS only if the full system is known to be correctly specified; even then 3SLS provides no gain if either (1) the contemporaneous correlations between the disturbances in different equations are all zero or (2) all equations are exactly identified (Johnston 1984, 489). The standard estimation procedure for the outcome equation of a quasi-experimental design is 2SLS (Achen 1986, 42); it is also commonly used in the literature on the effect of campaign spending to estimate the conventional temporally aggregated models.

[7] Expenditures are purchases or payments made to influence a federal election. Contributions are payments, services, or anything of value given to influence a Federal election. War chests, which are discussed later, are the campaigns' cash on hand. Cash on hand includes petty cash, funds held in checking and savings accounts, certificates of deposit, traveler's checks, treasury bills, and other investments valued at cost. See Federal Election Commission 1988.

[8] Green and Krasno (1988) developed a seven-point scale for a similar variable. We ran our analysis with both measures, and the results were not significantly different.

When the temporally aggregated model is appropriately understood, a theoretical as well as methodological difficulty becomes clear. As discussed in the previous section, incumbent spending is a process in which different goals are set for each stage of the election cycle. The determination of how incumbents spend throughout the election cycle is summarized in a single equation by aggregating the temporal process. Since the expected vote outcome E(V) plays an essential role in the assignment process, the question to ask is: *When* is the expectation supposed to take place? Certainly, as the campaign progresses, the expectation of the vote outcome is likely to change from time to time. A single, aggregated equation appears incapable of representing the dynamics involved in the determination of incumbent spending. To provide a more precise picture of the process, formulation of a dynamic assignment process is required. Such formulation, in turn, necessitates the specification of a set of dynamic outcome equations. Thus, a temporally disaggregated model comprising the interlocking relationship between money (assignment) and the vote (outcome) is in order.

The Dynamic Outcome Equations

Our temporally disaggregated vote equations are:

$$\begin{aligned} V_k = {} & \beta_{k1} + \beta_{k2}V_{k-1} + \beta_{k3}IE_k + \beta_{k4}CE_k \\ & + \beta_{k5}CPPO + \beta_{k6}P + u_{ko}, \qquad k = 1, \ldots, 7. \end{aligned} \tag{3}$$

The parallelism with the temporally aggregated outcome equation is apparent. Here V_k is a measure, which may be unobserved, at the end of period k concerning the "standing" of the incumbent in terms of winning the general election. The periods are chosen to conform to the seven Federal Election Commission (FEC) reporting periods.[9] V_7 thus corresponds to the general election outcome, which is, of course, observed. V_0, as defined earlier, is the vote outcome of the previous election. IE_k and CE_k are, respectively, the incumbent's and challenger's expenditures during period k. CPPO (challenger's prior political office holding) and P (incumbent's party) are defined as in the temporally aggregated

[9]The coverage dates of the periods are:
period 1 - January 1, 1985, to June 30, 1985
period 2 - July 1, 1985, to December 31, 1985
period 3 - January 1, 1986, to March 31, 1986
period 4 - April 1, 1986, to June 30, 1986
period 5 - July 1, 1986, to September 30, 1986
period 6 - October 1, 1986, to October 15, 1986
period 7 - October 16, 1986, to November 24, 1986

case; they are not period specific. u_{ko} is the disturbance term. Except for β_{k1}, the intercept, β_{k2} through β_{k6} are the period-specific regression coefficients indicating the effect of the respective explanatory variable on V_k in period k.

The final vote outcome, V_7, can be derived from the period-specific vote equations by repeated backward substitution as:

$$\begin{aligned} V_7 = &\sum_{k=1}^{7}\left(\prod_{i=k+1}^{7}\beta_{i2}\right)\beta_{k1} + \left(\prod_{i=1}^{7}\beta_{i2}\right)V_0 \\ &+ \sum_{k=1}^{7}\left(\prod_{i=k+1}^{7}\beta_{i2}\right)\beta_{k3}IE_k + \sum_{k=1}^{7}\left(\prod_{i=k+1}^{7}\beta_{i2}\right)\beta_{k4}CE_k \\ &+ \left[\sum_{k=1}^{7}\left(\prod_{i=k+1}^{7}\beta_{i2}\right)\beta_{k5}\right]CPPO \\ &+ \left[\sum_{k=1}^{7}\left(\prod_{i=k+1}^{7}\beta_{i2}\right)\beta_{k6}\right]P + \sum_{k=1}^{7}\left(\prod_{i=k+1}^{7}\beta_{i2}\right)u_{k0}, \end{aligned} \tag{4}$$

where $\prod$ is the usual notation for multiplication with the proviso that $\prod_{i=8}^{7}\beta_{i2} \equiv 1$.

With this formulation of the final vote outcome, it is interesting to see that, if $\beta_{k2} = 1$ for all k and $\beta_{k3} = \beta_3$ and $\beta_{k4} = \beta_4$ for all k with constants β_3 and β_4, the final vote outcome equation becomes:

$$\begin{aligned} V_7 = &\sum_{k=1}^{7}\beta_{k1} + V_0 + \beta_3\left(\sum_{k=1}^{7}IE_k\right) + \beta_4\left(\sum_{k=1}^{7}CE_k\right) \\ &+ \left(\sum_{k=1}^{7}\beta_{k5}\right)CPPO + \left(\sum_{k=1}^{7}\beta_{k6}\right)P + \sum_{k=1}^{7}u_{ko}. \end{aligned} \tag{5}$$

If we further set $\beta_1 = \sum_{k=1}^{7}\beta_{k1}$, $\beta_5 = \sum_{k=1}^{7}\beta_{k5}$, $\beta_6 = \sum_{k=1}^{7}\beta_{k6}$, and $u_o = \sum_{k=1}^{7}u_{ko}$, then, since $IE = \sum_{k=1}^{7}IE_k$ and $CE = \sum_{k=1}^{7}CE_k$,

$$V_7 = \beta_1 + \beta_2 V_0 + \beta_3 IE + \beta_4 CE + \beta_5 CPPO + \beta_6 P + u_o. \tag{6}$$

which is precisely the temporally aggregated vote equation except that β_2 is now constrained to 1. The coefficients β_1, β_5, and β_6 are just the sum of all their counterparts in the temporally disaggregated equations, and the disturbance u_o is the sum of all the period-specific shocks throughout the election cycle.

Thus, the traditional, temporally aggregated vote outcome equation (eq. 1) is a special case of our more general, temporally disaggregated

model (eq. 3). The traditional approach assumes that the effects of both incumbent's and challenger's expenditures on the vote outcome, as indicated by coefficients β_{k3} and β_{k4}, are constants for all periods. Such an assumption makes it possible to use the aggregated incumbent and challenger expenditures, IE and CE, respectively, as explanatory variables in a single vote outcome equation. Our theory stipulates that this static view of the effect of campaign expenditures is inappropriate. Instead, we provide an alternative hypothesis, which takes into account the dynamic nature of the campaign process.

More specifically, our temporally disaggregated model includes the following theoretical constraints and expectations over the parameters of the period-specific vote equations:

β_{k1}. β_{k1} is the intercept; *no constraints are imposed.*

β_{k2}. β_{k2} is positive for all k but, in general, can be greater than, less than, or equal to 1. We expect β_{k2} to be close to 1 for all k since the change in V_k from one period to another should be roughly incremental. β_{i2} cannot, however, be equal to β_{j2} if periods i and j are not equal intervals. Conceivably, the shorter the period, the closer its β_{k2} will be to 1. Since V_{k-1} for $k = 2, \ldots, 7$ is most likely unobserved, β_{k2} may not be directly estimable. The value of β_{k2} $(k = 2, \ldots, 7)$ can be determined, however, with a given β_{12} on the basis of two principles. First, it is dependent only upon the interval of a period; if the interval decreases to 0, β_{k2} should be monotonically approaching 1. Second, the partial coefficient that relates V_k to V_{k-2} is equal to the product of β_{k2}, which relates V_k to V_{k-1}, and $\beta_{k-1,2}$, which relates V_{k-1} to V_{k-2}. It is not difficult to verify that the following expression of β_{k2} satisfies these two principles:

$$\beta_{k2} = \beta_{12}^{(t_k - t_{k-1})/t_1} = e^{s(t_k - t_{k-1})} \quad \text{with } s = \log(\beta_{12})/t_1, \qquad k = 2, \ldots, 7, \tag{7}$$

where t_k is the time interval between the beginning of the election cycle (January 1 after the previous election) and the end of period k; $t_0 \equiv 0$.[10] Note that, if $\beta_{12} > 1$, then $s > 0$ and all $\beta_{k2} > 1$; if

[10] The actual dates are incorporated in order to account for differences in the lengths of the reporting periods. Each period, k, is transformed into time, t, which is measured in months. Thus $k = 1$ is equivalent to $t_k = 6$. Similarly for $k = 2$ through 7, t_k = 12, 15, 18, 21,21.5, and 22.13. Note that November 4, 1986, the election day, is used to calculate t_7. Although the end of period 7 is November 24, 1986, few if any expenditures occur after the election.

$\beta_{12} = 1$, then $s = 0$ and all $\beta_{k2} = 1$; and, if $\beta_{12} < 1$, then $s < 0$ and all $\beta_{k2} < 1$. With these constraints on the β_{k2}'s ($k = 2, \ldots, 7$), only β_{12} or, alternatively, s needs to be estimated.

β_{k3}. The sign of β_{k3} depends on the dynamics of the campaign process. β_{k3} is generally expected to be positive, but, since expenditures are made to secure a primary constituency during the second stage, the effect on the incumbent's interparty standing and the final vote outcome may be inconsequential or adverse. A negative effect signals that the intraparty focus is hurting the incumbent's general standing. Moreover, the β_{k3}'s for $k = 1, \ldots, 7$ is assumed to be constrained by a smooth curve in the real time dimension since the dynamics of the process are continuous. We expect that such a curve is a U-shaped function of t_k, $\beta_{k3} = f(t_k)$, with the trough falling slightly below the zero line during the second stage.

β_{k4}. Since there is no well-defined challenger before the primary, the CE_k terms for periods before the primary are dropped from the vote equations.[11] Alternatively, constraining the β_{k4}'s to zero for all the preprimary periods serves the same purpose. For the postprimary periods, since the dynamic process is approaching its final stage, the impact of CE_k on V_k is expected to be a negative *constant*, β_4. Overall $\beta_{k4} = \beta_4 I_k$, where $I_k = 0$ if k is a preprimary period for a district, and $I_k = 1$ if k is either the primary period or a postprimary period for a district. For all districts, $I_1 = I_2 = 0$ and $I_6 = I_7 = 1$.

β_{k5}. Although a challenger is not well defined until the primary, the field could have been previously determined. In general, the period k in which the (would-be) challenger's political quality starts to influence the incumbent's standing is probably best represented by a random variable. We assume that $k = 3$, the beginning of the election year, for all districts since this is when the candidate recruitment literature says that most challengers decide whether or not to run (Maisel 1986; Wilcox 1987). Consequently, $\beta_{15} = \beta_{25} = 0$. Changing the presumed starting period does not affect the estimation of the outcome equation, as long as the same k is assumed for all districts. β_{k5} ($k = 3, \ldots, 7$) is expected to be negative.

β_{k6}. β_{k6} is not constrained since the impact from short-term national partisan politics could vary from period to period.

[11] If the CE_k terms are not dropped, the conclusions are unchanged.

With these constraints, the final vote outcome equation becomes

$$\begin{aligned} V_7 = & \sum_{k=1}^{7}\left(\prod_{i=k+1}^{7}\beta_{i2}\right)\beta_{k1} + \left(\prod_{i=1}^{7}\beta_{i2}\right)V_0 \\ & + \sum_{k=1}^{7}\left(\prod_{i=k+1}^{7}\beta_{i2}\right)\beta_{k3}IE_k + \beta_4\sum_{k=1}^{7}\left(\prod_{i=k+1}^{7}\beta_{i2}\right)I_kCE_k \\ & + \left[\sum_{k=3}^{7}\left(\prod_{i=k+1}^{7}\beta_{i2}\right)\beta_{k5}\right]CPPO \\ & + \left[\sum_{k=1}^{7}\left(\prod_{i=k+1}^{7}\beta_{i2}\right)\beta_{k6}\right]P + \sum_{k=1}^{7}\left(\prod_{i=k+1}^{7}\beta_{i2}\right)u_{ko} \\ = & \beta_1 + \beta_2 V_0 + \sum_{k=1}^{7}(\beta'_{k3}IE_k) + \beta_4 CE' + \beta_5 CPPO + \beta_6 P + u_o, \end{aligned} \tag{8}$$

where

$$\beta_1 = \sum_{k=1}^{7}\left(\prod_{i=k+1}^{7}\beta_{i2}\right)\beta_{k1} \tag{9}$$

$$\beta_2 = \prod_{i=1}^{7}\beta_{i2} = \exp(st_7) \tag{10}$$

$$\begin{aligned} \beta'_{k3} &= \left(\prod_{i=k+1}^{7}\beta_{i2}\right)\beta_{k3} \\ &= \exp[s(t_7 - t_k)]\beta_{k3} \equiv \exp[s(t_7 - t_k)]f(t_k) \equiv g(t_k) \end{aligned} \tag{11}$$

$$CE' = \sum_{k=1}^{7}\left(\prod_{i=k+1}^{7}\beta_{i2}\right)I_kCE_k = \sum_{k=1}^{7}\exp[s(t_7 - t_k)]I_kCE_k \tag{12}$$

$$\beta_5 = \sum_{k=3}^{7}\left(\prod_{i=k+1}^{7}\beta_{i2}\right)\beta_{k5} = \sum_{k=3}^{7}\exp[s(t_7 - t_k)]\beta_{k5} \tag{13}$$

$$\beta_6 = \sum_{k=1}^{7}\left(\prod_{i=k+1}^{7}\beta_{i2}\right)\beta_{k6} = \sum_{k=1}^{7}\exp[s(t_7 - t_k)]\beta_{k6} \tag{14}$$

$$u_o = \sum_{k=1}^{7}\left(\prod_{i=k+1}^{7}\beta_{i2}\right)u_{ko} = \sum_{k=1}^{7}\exp[s(t_7 - t_k)]u_{ko}. \tag{15}$$

Some explanations about CE′ are in order: First, if p is the primary period for a district, the CE_p used in calculating CE′ should include

only the proportion of the CE_p spent *after* the primary. Second, it is noted that, in order to calculate CE′, s needs to be estimated first. Although we do have a method by which to estimate s, we suggest simply replacing CE′ with the postprimary aggregate challenger expenditures. Such replacement implies that the β_{k2}'s are set to 1 in order to weight the postprimary CE_k's. Since the postprimary period is relatively short for most districts and our theory does not postulate crucial dynamics during the general election stage, this approach seems to be justified.[12]

Our primary interest is in the β_{k3}'s. Since $\beta_{k2} > 0$ for all k, β'_{k3} is of the same sign as β_{k3}. Furthermore, if β_{k3} is constrained in real time by $f(t_k)$, that is, $\beta_k = f(t_k)$, then β'_{k3} is constrained by a function $g(t_k) \equiv \exp[s(t_7 - t_k)] f(t_k)$, which is a smooth curve since f is a smooth curve. g will be different from f since the farther away from the election (the smaller k gets), the more the f curve will be "pulled" toward (if $s < 0$) or away from (if $s > 0$) the zero line due to the cumulative weight parameter $\exp[s(t_7 - t_k)]$. We propose to approximate $g(t_k)$ with an Almon polynomial (Almon 1965; Judge et al. 1988, 729-34) of an order $r \leq 6$:

$$\beta'_{k3} = g(t_k) \approx \sum_{i=0}^{r} \omega_i t_k^i. \tag{16}$$

The shape of the Almon polynomial provides a means to test for the differential effects of timing and provides insight that is not available with other methods. We chose the Almon polynomial because: (1) time is continuous and we believe that whatever dynamic there is, it must be a "smooth" one, and smooth dynamics can be approximated by a polynomial; (2) methodologically, the Almon polynomial is often used to avoid multicollinearity, which is likely to be a problem when disaggregated expenditures for all seven periods are included in a regression; and (3) since we theorized about a U-shaped curve connecting the β_{k3}'s (and hence β'_{k3}'s), we expect a polynomial of order $r \geq 2$; an order of zero would amount to the null hypothesis of no dynamics in the effects, as implied in the temporally aggregated analyses.[13]

[12] If one insists in estimating s, we suggest this procedure: Replace CE′ with the postprimary aggregate challenger expenditures and use OLS on the final vote outcome equation to estimate β_2. Take $\hat{s} = \log(\hat{\beta}_2)/t_7$ as the initial estimate of s and reestimate the final vote outcome equation in its complete form. A new $\hat{\beta}_2$ is derived and compared with the previous estimate. If necessary, repeat these steps. Our final results give $\hat{\beta}_2 \approx .5$. It follows that $\hat{s} = -0.0304$, which in turn leads to $\hat{\beta}_{12} = \hat{\beta}_{22} = 0.83$, $\hat{\beta}_{32} = \hat{\beta}_{42} = \hat{\beta}_{52} = 0.91$, $\hat{\beta}_{62} = 0.98$, and $\hat{\beta}_{72} = 0.96$. As expected, these values are close to 1; the shorter a period is, the more so. All the postprimary $\hat{\beta}_{k2}$'s are greater than .9 but smaller than 1.

[13] The results of using a Shiller lag do not differ significantly. Specifically, there

By substituting β'_{k3} with $\sum_{i=0}^{r} \omega_i t_k^i$, it can be shown that

$$\begin{aligned} V_7 &= \beta_1 + \beta_2 V_0 + \sum_{k=1}^{7} \left(\sum_{i=0}^{r} \omega_i t_k^i IE_k \right) + \beta_4 CE' \\ &\quad + \beta_5 CPPO + \beta_6 P + u_o \\ &= \beta_1 + \beta_2 V_0 + \sum_{i=0}^{r} \left(\omega_i \sum_{k=1}^{7} t_k^i IE_k \right) + \beta_4 CE' \\ &\quad + \beta_5 CPPO + \beta_6 P + u_o. \end{aligned} \tag{17}$$

This equation is linear in both the parameters and the explanatory variables.

Finally, the disturbance term is now a linear combination of the u_{ko}'s, each of which is weighted according to the time interval between the occurrence of the shock and the general election. If $s < 0$, the closer a shock is to the election, the more weight is given to it. If $s > 0$, the farther away a shock is from the election, the more weight is given to it.

The Dynamic Assignment Equations

Although the previously described final vote outcome equation is directly estimable by OLS, the problems of quasi experiment, in this case the nonrandom assignment of the expenditures, still need to be addressed. In determining the level of expenditures, the incumbent is first subjected to the constraints of his or her contributions (and war chest). Contributions have their own dynamic assignment process, which is primarily contingent upon the standing of the incumbent in terms of the chance of winning the general election. We propose the following incumbent receipt equations:

$$IM_1 = \gamma_{11} + \gamma_{12} IM_0 + \gamma_{13} V_0 + w_1 \tag{18}$$

$$\begin{aligned} IM_k &= \gamma_{k1} + \gamma_{k2} IM_{k-1} + \gamma_{k3} [V_{k-1} - E(V_{k-1})] + w_k \\ &= \gamma_{k1} + \gamma_{k2} IM_{k-1} + \gamma_{k3} v_{k-1} + w_k, \qquad k = 2, \ldots, 7. \end{aligned} \tag{19}$$

Here IM_k is the contributions the incumbent received during period k as reported to the FEC. IM_0 is the incumbent's temporally aggregated receipts in the previous election cycle. Except for period 1, when contributions are determined by the incumbent's previous fund-raising ability (indicated by IM_0) and his or her performance in the previous

is only a two percent difference (Nathaniel Beck, personal conversation, September 1992). The Almon lag is flexible and therefore incorporates many alternative lag structures.

election (V_0), the equations reflect the campaign dynamics that Aldrich (1980a, 1980b) found in the presidential primary process. Beyond a continuity factor (IM_{k-1}), receipts during a period are primarily determined by the incumbent's actual standing at the end of the previous period (V_{k-1}) compared with the expected standing [$E(V_{k-1})$]. If the actual standing is stronger than expected, there will be an increase in contributions. A weaker than expected standing, on the other hand, will result in a decrease. The unexpected performance in standing, $v_{k-1} = V_{k-1} - E(V_{k-1})$, is thus what motivates contributors to keep investing their money in the incumbent. It is assumed that there is no correlation between v_{k-1} and the disturbance term w_k, that is, $\mathrm{Cov}(v_{k-1}, w_k) = 0$.

The measurement of v_k requires periodic polling throughout the election cycle. Although such polling information may be available in some districts, the sporadic availability of such information will not enable us to estimate directly the contribution equations over the entire election cycle without selection bias.[14] Nevertheless, these receipts equations are important for the specification of the assignment process of expenditures. The expenditure equations are:

$$IE_1 = \delta_{11} + \delta_{12}IE_0 + \delta_{13}IW_0 + \delta_{14}IM_1 + \delta_{15}V_0 + u_{1a} \tag{20}$$

$$\begin{aligned} IE_k &= \delta_{k1} + \delta_{k2}IE_{k-1} + \delta_{k3}IW_{k-1} + \delta_{k4}IM_k \\ &\quad + \delta_{k5}[V_{k-1} - E(V_{k-1})] + \delta_{k6}CE_{k-1} + u_{ka} \\ &= \delta_{k1} + \delta_{k2}IE_{k-1} + \delta_{k3}IW_{k-1} + \delta_{k4}IM_k \\ &\quad + \delta_{k5}v_{k-1} + \delta_{k6}CE_{k-1} + u_{ka}, \qquad k = 2, \ldots, 7. \end{aligned} \tag{21}$$

IE_0 is the incumbent's expenditures in the previous election cycle. IW_{k-1} ($k = 2, \ldots, 7$) is the incumbent's war chest at the end of the period prior to the current period k, and IW_0 is the incumbent's war chest at the end of the previous election cycle. The inclusion of IW_{k-1} and IM_k in these equations thus reflects the financial constraints on expenditures. And, in this sense, we consider IM_k as *predetermined* since, in deciding whether

[14] The polling dates do not coincide with the dates of the reporting periods, and most candidates do not have enough money to commission more than four or five polls in a two-year election cycle (Wally Mealeia, William Hamilton and Associates, telephone conversation, June 26, 1992). William Hamilton and Associates is a nationally recognized political campaign polling firm. Green, Robins, and Krasno (1991) focus on the sixth and seventh reporting periods and use only 25 House races for which polling information is available. Their data were obtained from the Republican National Committee. These races were targeted for polling because of the competitive nature of the district. Kenny and McBurnett (1992) use a panel survey of individuals, which was conducted during the approximately seven and a half weeks prior to election day, for one House race in 1984.

to make an expenditure, the incumbent should have up-to-date information about the amount of funds being raised in the current period. The relevance of IE_{k-1} is apparent, but it also picks up what Green, Robins, and Krasno (1991, 6) call "the incumbent's enduring propensity to raise and spend campaign funds."[15] CE_{k-1} is also included because the incumbent, upon reading the information from FEC reports, must respond to the challenger's spending strategy.[16] V_0 is included in the equation for IE_1 to serve as an initial estimate of the strength of the prospective opposition. From period 2 on, $v_{k-1} = \mathrm{V}_{k-1} - \mathrm{E}(\mathrm{V}_{k-1})$ replaces V_0 in the assignment equations because the incumbent must now respond to unanticipated shocks in his or her standing.[17] Finally, it is again assumed that $\mathrm{Cov}(v_{k-1}, u_{ka}) = 0$.

Since v_{k-1} is considered latent, it is solved for by using the contribution equations and then substituting into the expenditure equations to derive:

$$\begin{aligned}\mathrm{IE}_k = {} & (\delta_{k1} - \delta_{k5}\gamma_{k1}/\gamma_{k3}) + \delta_{k2}\mathrm{IE}_{k-1} + \delta_{k3}\mathrm{IW}_{k-1} \\ & + (\delta_{k4} + \delta_{k5}/\gamma_{k3})\,\mathrm{IM}_k - (\delta_{k5}\gamma_{k2}/\gamma_{k3})\,\mathrm{IM}_{k-1} \\ & + \delta_{k6}\mathrm{CE}_{k-1} + u'_{ka}, \qquad k = 2, \ldots, 7.\end{aligned} \tag{22}$$

where $u'_{ka} = u_{ka} - (\delta_{k5}/\gamma_{k3})w_k$. This "reduced form" can be estimated with OLS since all variables are observed, and IM_k is considered as predetermined.

The expenditure equations are the primary focus since expenditures are the debated source of endogeneity in the outcome equations. It is unfortunate that the endogeneity of incumbent expenditures has been debated in the temporally aggregated context. The process in which expenditures are made involves period-to-period, unidirectional, causal dynamics so that only a temporally disaggregated approach is adequate

[15] IE_0 is replaced in equation 21 with IE_{k-1} because the most recent spending information is considered to be a more accurate prediction of current spending than is spending information from last year's campaign since greater differences are likely (i.e., different competitors and national conditions).

[16] The challenger's receipts in the previous period, to which the incumbent could also respond, are excluded because of its high correlation with expenditures.

[17] Green, Robins, and Krasno (1991, 6) note: "How do incumbents know that they are in a tough race? For one thing, they can read FEC reports to determine the amount raised and spent by the opposition. Second, they can discern the general caliber of the opposition, based on the political experience of the challenger. Finally, they can look to opinion polls for some sense of how voters are likely to behave. Thus, ... one must control for challenger spending, challenger quality, and the polling information available to incumbents." We exclude the challenger quality variable (CPPO), which is not period specific, because we feel that its effect has been picked up by challenger spending (CE_{k-1}) and the unanticipated shocks in standing (v_{k-1}), both of which are period-specific variables.

in analyzing the assignment process in this quasi experiment. By temporal disaggregation, the process is triangularized and the problem of endogeneity is put in a totally different perspective.

The system is triangular but not necessarily recursive. If the disturbance terms of the assignment equations are correlated with the disturbance term of the final vote outcome equation, contemporaneous correlation will result in inconsistent OLS estimates. For example, scandals are a conceivable factor that influences money raised, and hence money spent, in each period. The same scandals are also likely to influence the vote in the general election. Since the occurrence (or nonoccurrence) of scandals is not explicitly included in the equations as an explanatory variable, it is a component of the disturbance terms. Nonrandom assignment, together with contemporaneous correlation, can cause severe inconsistency of OLS estimators if the impact of such a factor is substantial. As an informal test, the correlations between the residuals of the assignment (IE_k) equations and the residual of the final vote outcome (V_7) equation can be examined to determine whether contemporaneous correlation is a problem. If the correlations are significant, then it is necessary to use 2SLS to estimate the final vote outcome equation. We do not expect the correlations between $\hat{u}'_{ka}$ and $\hat{u}_o$ to be substantial because v_{k-1} has been excluded from w_k and u_{ka}, and hence from u'_{ka}, in the preceding specifications.[18]

Data and Results

The data consist of 246 House elections in which an incumbent ran for reelection in 1986.[19] Table 1 provides descriptive statistics for the

[18] We treat CE′ and CPPO, as well as the CE_k's as exogenous. Unlike the incumbent, the challenger spends everything he or she raises as quickly as possible regardless of the expected vote. Green and Krasno (1988, 904) also argue that endogeneity is a less serious problem for challenger spending than incumbent spending is because "a majority of challengers in the sample are of such low quality that it seems unlikely that they could gain access to financial backing, even when expectations rise." The exogeneity of CPPO, which is an indicator of a challenger's political quality, is more difficult to establish. However, even if challenger quality is endogenous, its assignment is mostly explained by the *status of incumbency* and not by incumbent spending. See Banks and Kiewiet (1989) for how the low probability of winning deters strong rivals from challenging the incumbent but does not prevent weak ones from trying. Since we consider only races in which an incumbent faces a major party challenger, it is unlikely that challenger quality and disturbance term, that is, the part of the vote that is not captured by the final vote outcome equation, are substantially correlated.

[19] Data from 1986 were used to facilitate the comparison of our results with existing research, which includes work by Ansolabehere (1990), Green and Krasno (1990), Jacobson (1990), Bartels (1991), and Green, Robins and Krasno (1991), and because the 1986 data are the most complete and detailed FEC data currently available from

expenditures and contributions of both incumbents and challengers.[20] The election cycle is divided into seven FEC reporting periods within each of which the statistics are calculated.

Temporal disaggregation of these statistics provides the first insight into the dynamics of the campaign finance process. Incumbents' mean expenditures and contributions dwarf those of the challengers in every period. Furthermore, incumbents receive and spend money earlier than challengers do. As a matter of fact, the median challenger does not raise and spend any money until the fourth period, when the primary season has already begun. In terms of the proportion of the overall mean in each period, incumbents and challengers clearly receive contributions and make expenditures with a different temporal pattern.

The correlation between challengers' contributions and expenditures for each period is quite high, ranging from .89 to .96. In contrast, the same correlation for incumbents is much lower, ranging from .46 to .78. With more contributions in the early periods, incumbents, unlike challengers, do not have to spend immediately most of what they receive. Their use of such relative financial freedom suggests that the timing of spending is part of the incumbents' strategic calculations.

To analyze the effect of spending, it should be noted that money is typically considered to have a concave production function. To analyze the changing effect of spending independent of the diminishing marginal returns of expenditures, some kind of transformation on the monetary terms needs to be taken before fitting the dynamic assignment and outcome equations. In other words, we consider the concavity of the production function of money as an a priori assumption, and test the

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the Inter-University Consortium for Political and Social Research. We exclude first-term incumbents and districts without major party challengers, as did Green and Krasno (1990, 366-67).

We are grateful to Donald Green and Larry Bartels-and indirectly to Stephen Ansolabehere and Gary Jacobson-for providing some of these data. The monetary data were obtained from ICPSR. The data for "Campaign Expenditures in the United States, 1985-86: Freedom of Information Act (FOIA) Data" were originally collected and prepared by the FEC. Neither the collector of the original data nor the consortium bears any responsibility for the analyses or interpretations presented here.

[20] The FEC reporting rules mean that delayed payment of bills is not a problem for the analysis. Specifically: "A written agreement to make an expenditure, such as a media contract, constitutes an expenditure" (Federal Election Commission 1988, 18). Thus, candidates cannot "hide" expenditures by having television advertisements shown, polls conducted, and so on, before the election and not paying for them until after the election. Purchasing services long before they will be rendered, and thereby biasing the period expenditures, is also not likely to be a problem. It is our understanding that this does not occur because candidates like to have their cash on hand until the time when the services will be provided (Wally Mealeia, William Hamilton and Associates, telephone conversation, June 26, 1992).

TABLE 1. Disaggregation of Money by Reporting Period for Incumbents and Challengers

	Incumbents			Challengers		
	Mean ($)	Portion of the Total	Median ($)	Mean ($)	Portion of the Total	Median ($)
Expenditures						
1	29,153	0.09	23,233	1,203	0.01	0
2	34,649	0.11	27,630	3,168	0.03	0
3	23,587	0.07	17,209	7,072	0.07	0
4	41,284	0.13	33,348	19,951	0.19	6,284
5	88,015	0.28	70,126	34,546	0.33	13,052
6	33,759	0.11	24,044	12,203	0.12	4,029
7	68,517	0.21	51,228	25,997	0.25	9,256
$\sum_1^7$	318,964		280,595	104,141		43,485
Contributions						
1	42,331	0.13	33,408	1,286	0.01	0
2	62,991	0.17	49,517	4,206	0.04	0
3	38,228	0.10	28,135	8,636	0.08	0
4	69,520	0.19	60,935	24,005	0.23	8,437
5	78,885	0.22	66,577	33,531	0.32	13,925
6	23,719	0.06	18,024	10,859	0.11	4,109
7	50,902	0.14	39,917	20,724	0.20	6,897
$\sum_1^7$	366,576		335,597	103,247		44,415

Source: Calculated by the authors from Federal Election Commission Publications.
Note: $N = 246$.

changing effect of spending on the basis of such an assumption.

Conventionally, the log transform is used to deal with the problem of diminishing returns. Because the logarithmic function is not defined when its argument is nonpositive, usually a sufficiently large positive constant is added before taking logs. Using the Box-Cox procedure, Jacobson (1990) concludes that the appropriate constant is $5,000 for the aggregated model, and Green and Krasno (1990) concur. Since we disaggregate the process into seven periods, our constant should be accordingly $\$5,000/7 \approx \$714$.

By taking logs on the disaggregated terms, the claim that the aggregated model is nested within the disaggregated model needs to be modified. The claim is still valid if one considers the "logged cumulative

ratios" as follows:

$$\mathrm{IE}''_1 = \log(\mathrm{IE}'_1) \tag{23}$$

$$\mathrm{IE}''_k = \log\left(\frac{\mathrm{IE}'_1 + \mathrm{IE}'_2 + \cdots + \mathrm{IE}'_k}{\mathrm{IE}'_1 + \mathrm{IE}'_2 + \cdots + \mathrm{IE}'_{k-1}}\right), \qquad k = 2, \ldots, 7 \tag{24}$$

$$= \log\left(\sum_{i=1}^{k} \mathrm{IE}'_i\right) - \log\left(\sum_{i=1}^{k-1} \mathrm{IE}'_i\right),$$

where $\mathrm{IE}'_k = \mathrm{IE}_k + (5,000/7)$. Instead of assessing the yield of money spent in each period separately, this transform assumes that yield is evaluated cumulatively, starting from the first period. That is, the cumulative yield up to period k is $\log(\sum_{i=1}^{k} \mathrm{IE}'_i)$, and hence the yield of money spent in period k is $\log(\sum_{i=1}^{k} \mathrm{IE}'_i) - \log(\sum_{i=1}^{k-1} \mathrm{IE}'_i)$. If the effect of expenditures on the final vote is a constant for all periods, the logged cumulative ratios ensure that the total yield for the election cycle is $\sum_{k=1}^{7} \mathrm{IE}''_k = \log(\sum_{k=1}^{7} \mathrm{IE}'_k) = \log(\sum_{i=1}^{k} \mathrm{IE}_k + 5,000)$. Thus, the conventional aggregated model with log transform remains a special case of the disaggregated model. Moreover, it can be shown that, with the logged cumulative ratios, the marginal yield of money is kept continuous across periods. That is, after the transformation, the yield of the last dollar spent in a period is equal to the yield of the first dollar spent in the next period.

Despite these mathematical properties, we opted for the simple log transform rather than taking logged cumulative ratios. Granting that any transformation (including the raw form) always involves a certain degree of "scale indeterminacy," we made our decision on both theoretical and empirical grounds. First, the very idea of a temporally disaggregated model is based on the understanding that timing is critical in campaign strategies and that candidates periodically assess their standing and financial situation in making strategic moves. The FEC periodization provides a reasonable schedule for the candidates to "stop and think" and reevaluate the yield of their money. Moreover, the FEC periodization imposes time-period constraints upon when monetary, especially expenditure, information is available. Hence, a "discretized" scale is more consistent with our goal of studying campaign dynamics. Second, by rejecting the conventional aggregated model as inadequate, we rely on our modeling of the temporally disaggregated assignment process to demonstrate the validity of the simple log transform. Our expenditure equations (eq. 22) specify our substantive understanding of the campaign finance assignment process; any chosen transformation on the monetary terms has to ensure the empirical validation of these equa-

tions. Trying the simple log transform, the logged cumulative ratios, and the raw form for all monetary terms in estimating the expenditure equations, we find that the simple log transform produces results that are most supportive of our specification of the assignment process.[21]

The estimates of the assignment equations are shown in table 2. Incumbent expenditures are significantly affected by both lagged incumbent expenditures and current incumbent contributions for all periods, as expected. Lagged challenger expenditures are significant only for the last three periods. This is not surprising since only well into the primary season is the challenger clearly identified, and only then does the incumbent begin to focus on interparty competition and respond to the challenger's expenditures. A few coefficients for lagged incumbent contributions and war chest do not attain statistical significance in early periods, which again reflects the preprimary uncertainty but may also be indicative of initial financial restraints. For all the significant coefficients, the signs are consistent with expectations.

The R^2's for the assignment equations show that between one-half to two-thirds of the variance is explained. Thus, even without explicitly including polling information, the fit is good for all equations.

Before the outcome equation can be estimated, the order of the Almon polynomial, r, needs to be determined. This is done by starting from the highest possible order as the alternative hypothesis and testing the null hypothesis that the order is one degree lower using an F-test. The order of the last null hypothesis that cannot be rejected is chosen (Judge et al. 1988, 731-32).[22] In general, the order of an Almon polynomial is not expected to be greater than four (Beck 1990). We have found that $r = 2$, consistent with the expectation of a quadratic curve.

The OLS estimates for the final vote outcome equation with a second-order Almon polynomial are shown in table 3. There is no cross-equation correlation between the residuals of the assignment equations and outcome equation, so nonrecursiveness is not a problem.[23] We recognize the possibility of Type II error, however, and therefore estimate the system using 2SLS by replacing the IE_k's with the predicted values from the assignment equations. The results are similar, confirming the

[21] In particular, using the logged cumulative ratios not only substantially reduces the $\bar{R}^2$'s of most of the expenditure equations but it renders insignificant and/or negative the estimated coefficients of IE_{k-1}, which represents the incumbent's propensity to spend. See table 2 and the subsequent discussion.

[22] Since a sequence of tests is involved, the size of the tests is $1 - (1 - \alpha)^j$ for a sequence of j tests, where α the size of each individual test (Beck 1990, 3). In our search for the order of the Almon polynomial, we use the conventional $\alpha = .05$.

[23] The correlations among the residuals of the assignment equations are also very low, all less than 0.18.

TABLE 2. OLS Estimates for the Assignment Equations of Incumbent Expenditures in Each Period

Period k	1	2	3	4	5	6	7
Intercept	−0.33	2.40***	0.10	1.67**	−1.77***	−3.61***	0.98
	(0.83)	(0.54)	(0.63)	(0.55)	(0.67)	(0.94)	(0.65)
Lagged incumbent's	0.31***	0.28***	0.41***	0.15***	0.25***	0.31***	0.08*
expenditures	(0.70)	(0.05)	(0.07)	(0.05)	(0.07)	(0.09)	(0.04)
Lagged challenger's	—	−0.06	0.02	0.01	0.10***	0.12***	0.09***
expenditures		(0.04)	(0.03)	(0.02)	(0.02)	(0.04)	(0.03)
Lagged incumbent's	0.12***	−0.03	0.09**	−0.06	0.09**	0.27***	0.08**
war chest	(0.03)	(0.03)	(0.04)	(0.04)	(0.04)	(0.05)	(0.04)
Incumbent's	0.53***	0.50***	0.41***	0.62***	0.61***	0.25***	0.57***
contributions	(0.03)	(0.04)	(0.04)	(0.04)	(0.05)	(0.07)	(0.06)
Lagged incumbent's	—	0.03	0.02	0.10**	0.14**	0.31***	0.13***
contributions		(0.04)	(0.06)	(0.05)	(0.07)	(0.10)	(0.05)
Incumbent's	−0.02	—	—	—	—	—	—
previous vote	(0.005)						
Adj. R^2	0.69	0.66	0.59	0.61	0.65	0.52	0.59

Source: Calculated by the authors from Federal Election Commission Publications.

Note: Standard errors are in parentheses. *$p < .10$ **$p < .05$ ***$p < .01$.

TABLE 3. Estimates for Incumbent Vote in 1986 House Elections (OLS with Almon Coefficients for Incumbent Expenditures)

	Regression Coefficient	Standard Error
Intercept	57.549	(7.286)***
Incumbent's previous vote	0.505	(0.043)***
Incumbent's expenditures:		
Almon coefficient 1	3.576	(1.272)***
Almon coefficient 2	−0.514	(0.200)***
Almon coefficient 3	0.016	(0.007)***
Challenger's postprimary expenditures	−2.778	(0.292)***
Challenger's prior political office	−1.936	(0.839)**
Incumbent's party	4.136	(0.622)**

Source: Calculated by the authors from Federal Election Commission Publications.
Note: Adj $R^2 = 0.72$. N = 246. $^*p < .10$ $^{**}p < .05$ $^{***}p < .01$.

appropriateness of OLS.

The estimates show that, in the determination of the final vote outcome, the previous vote (V_0), challenger's postprimary expenditures (CE′), challenger's prior political office (CPPO), and incumbent's party (P) all have a significant effect in the expected direction. The most interesting part of the results is the estimated Almon polynomial for the incumbent's expenditures. The coefficients for the quadratic, $\hat{\omega}_i$'s, are all highly significant. The evidence strongly supports our hypothesis that the effect of incumbent expenditures varies over time.

Figure 1 shows the estimated Almon polynomial representing the time-varying effects of incumbent expenditures over the course of the entire election cycle. The two curves pertain to OLS and 2SLS estimation, respectively.[24] Although 2SLS gives a larger early effect and a somewhat smaller late effect, the dynamics are essentially identical with those of OLS. For comparisons, figure 1 also contains the unrestricted OLS coefficients and the recovered period-specific coefficients derived from the OLS estimation of the Almon polynomial.

As expected, the effect of temporally disaggregated incumbent expenditures on the final vote outcome is a U-shaped curve over the seven FEC periods. The zero line suggest three stages – early, middle, and late. The largest effect of expenditures clearly occurs at the first stage. The second stage does indicate that, although expenditures made during this stage may be conducive to winning the primary and building a primary constituency, the resulting division within the party and the

[24] When employing 2SLS, equations 18 and 19 estimate instruments, which are then utilized in equations 20 and 22.

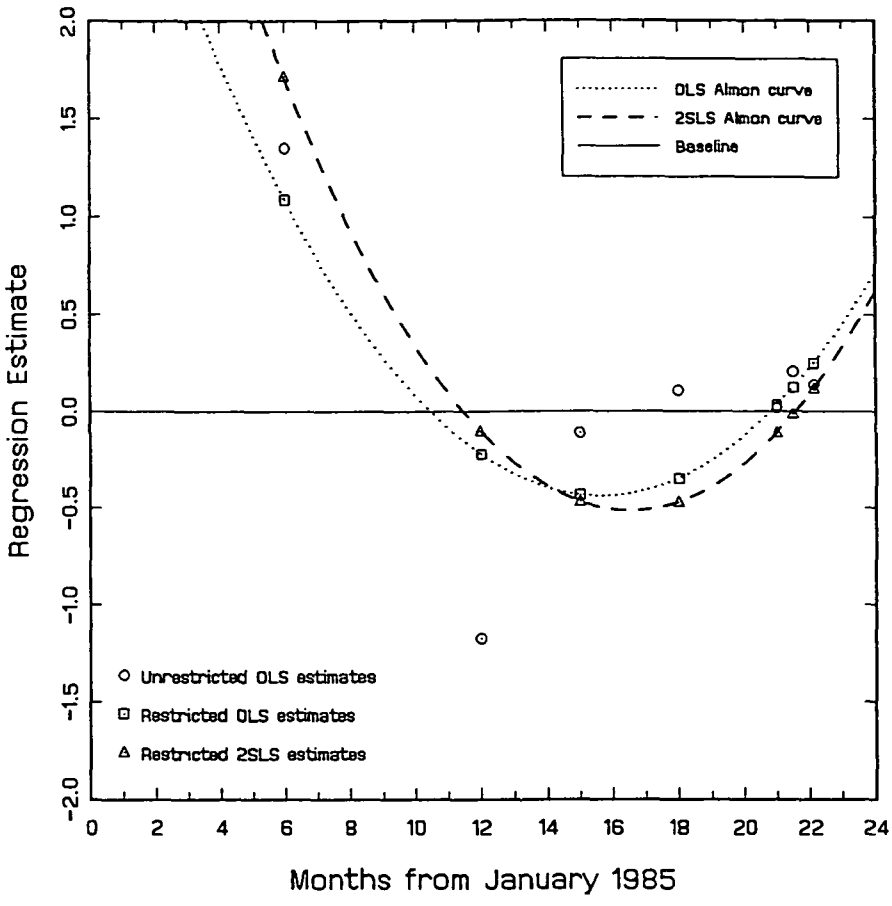

Fig. 1. Time-varying effects of incumbent expenditures on the final vote, 1985–86

agenda-setting dilemma turn out to be detrimental to the maximization of votes in the general election. The positive expenditures effect returns in the third stage. However, we note that the estimated effect for this stage is not particularly strong.[25]

[25] Although the three estimated Almon coefficients are all statistically significant, the coefficient associated with the quadratic term, which determines the curvature of a quadratic polynomial, is small. Mathematically, since $\hat{\beta}'_{k3} \approx \sum_{i=0}^{2} \hat{\omega}_i t_k^i$ $(k = 1, \ldots, 7)$, it is possible to calculate the standard errors of $\hat{\beta}'_{k3}$ from the variances and covariances of the $\hat{\omega}_i$'s $(i = 0, \ldots, 2)$. However, we are not so much concerned with the effect in an individual period as with the overall effect during a stage and the change from stage to stage, which is why we utilize the Almon polynomial. The point estimates for the third stage are consistent with Green, Robins, and Krasno (1991),

Concluding Remarks

The empirical test provides statistical evidence supporting our prior expectation that, at different stages of the campaign process, the effects of incumbent spending on the final vote vary. That is, there is a dynamic element in incumbent spending across the course of an election cycle and early money gives the biggest bang for the buck. Given the existence of the dynamics in expenditures, the implication of our research is that current models of money in campaigns are fundamentally misspecified. Traditional models designed for analysis of aggregate data can obscure important campaign dynamics. This suggests that we need a new class of theoretical and statistical models to understand candidate and contributor campaign strategies and election outcomes.

Our dynamic model also suggests the relevance of a dynamic game (Chow 1983, 395-96). In this game the candidates are decision makers who choose a spending level to maximize the chance of winning at each period and derive their optimal behavior from their standing at the previous period as well as past values of control variables. Chow (395-402) discusses the estimation of such a dynamic game model in the context of time-series analysis. Since our data are essentially cross-sectional with seven time periods, estimation procedures similar to those used in pooled time-series analysis would have to be developed if the dynamic game model is applied to the study the effect of campaign spending. Such a formal model, however, offers a particularly promising route for future research.

Our analysis provides a more comprehensive perspective, which should be used to examine strategic behavior in campaigns, and is essential to understanding elections. The timing of monetary transactions is clearly one of the most important components of a campaign and brings the politics into clearer focus. In this paper, we provide a substantive understanding that at different stages of the campaign process candidates have different goals and spend accordingly. To our knowledge, the dynamics of goal development and the temporal pattern of goal-oriented spending have not been thoroughly studied in the campaign literature. We hope our work can bring more attention to this important aspect of the campaign process.

From a methodological viewpoint, our work shows the significance of specifying dynamic models of campaign expenditures based on disaggregated data from many time points. The best way to find the true

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who studied incumbent spending in the sixth and seventh periods for 25 races polled by the Republican National Committee; they found a similar positive effect on the vote.

and important effects of rational strategic behavior is to exploit the fact that a campaign takes place over time, not at any single point in time. This longitudinal perspective is relevant not only for models of campaign finance but for more general political science models in which the strategic timing dimension has generally been overlooked.

REFERENCES

Abramowitz, Alan I. 1988. "Explaining Senate Election Outcomes." *American Political Science Review* 82:385–403.

———. 1991. "Incumbency, Campaign Spending, and the Decline of Competition in U.S. House Elections." *Journal of Politics* 53:34–56.

Achen, Christopher H. 1986. *The Statistical Analysis of Quasi-Experiments.* Berkeley: University of California Press.

Aldrich, John H. 1980a. *Before the Convention: Strategies and Choices in Presidential Nomination Campaigns.* Chicago: University of Chicago Press.

———. 1980b. "A Dynamic Model of Presidential Nomination Campaigns." *American Political Science Review* 74:651–69.

Alexander, Herbert E. 1972. *Financing the 1972 Election.* Lexington, MA: Lexington Books.

Allis, Sam. 1992. "Broke but Unbowed." *Time*, March 20.

Almon, Shirley. 1965. "The Distributed Lag between Capital Appropriations and Expenditures." *Econometrica* 33:178–96.

Ansolabehere, Stephen. 1990. "Winning Is Easy, But It Sure Ain't Cheap." Manuscript.

Bailey, Christopher J. 1990. "The U.S. Congress: An Introductory Bibliography." *American Studies International* 28:32–48.

Banks, Jeffrey S., and D. Roderick Kiewiet. 1989. "Explaining Patterns of Candidate Competition in Congressional Elections." *American Journal of Political Science* 33:997–1015.

Bartels, Larry M. 1988. *Presidential Primaries and the Dynamics of Public Choice.* Princeton: Princeton University Press.

———. 1991. "Instrumental and 'Quasi-Instrumental' Variables." *American Journal of Political Science* 35:777–800.

Beaudry, Ann and Bob Schaeffer. 1986. *Winning Local and State Elections: The Guide to Organizing Your Campaign.* New York: Free Press.

Beck, Nathaniel. 1990. "Testing for a Political Business Cycle with Distributed Lag Models: A Note." Paper presented at the 1990 Annual Meeting of the Political Methodology Society, Washington University, St. Louis, July 1990.

Bedlington, Anne H., and Lynda W. Powell. 1986. "Money and Elections." In *Research in Micropolitics*, edited by Samuel Long. Greenwich, CT: JAI Press.

Biersack, Robert, Paul Herrnson, and Clyde Wilcox. 1993. "Seeds for Success: Early Money in Congressional Elections." *Legislative Studies Quarterly* 18:535–52.

Biersack, Robert, and Clyde Wilcox. 1990. "Financing National Campaigns: A Research Agenda." *American Politics Quarterly* 18:215–42.

Cheney, Richard B. 1980. "The Law's Impact on Presidential and Congressional Election Campaigns." In *Parties, Interest Groups, and Campaign Finance Laws*, edited by Michael J. Malbin. Washington, DC: American Enterprise Institute for Public Policy Research.

Chow, Gregory C. 1983. *Econometrics*. New York: McGraw-Hill.

Costantini, Edmond, and Joel King. 1982. "Checkbook Democrats and Their Copartisans." *American Politics Quarterly* 10:65–92.

Epstein, David and Peter Zemsky. 1992. "Money Talks: A Signalling Approach to Campaign Finance." Paper presented at the Annual Meeting of the Midwest Political Science Association, Chicago, Illinois.

Erikson, Robert, and Thomas B. Palfrey. 1992. "The Puzzle of Incumbent Spending in Congressional Elections." Paper presented at the Annual Meeting of the Political Methodology Society, Harvard University, Cambridge, Massachusetts.

FaithAmerica Foundation. 1982. *The Citizens Guide to Winning Elections*. Scottsdale, AZ: FaithAmerica Press.

Federal Election Commission. 1988. *Campaign Guide for Congressional Candidates and Committees*. Washington, DC: Government Printing Office.

Feldman, Paul, and James Jondrow. 1984. "Congressional Elections and Local Federal Spending." *American Journal of Political Science* 25:424–39.

Fenno, Richard F., Jr. 1978. *Home Style: House Members in Their Districts*. Boston: Little and Brown.

Franklin, Charles H. 1993. "Senate Incumbent Visibility over the Election Cycle." *Legislative Studies Quarterly* 18:271–90.

Fritz, Sara, and Dwight Morris. 1992. *Handbook of Campaign Spending: Money in the 1990 Congressional Races*. Washington, DC: Congressional Quarterly Press.

Glantz, Stanton A., Alan I. Abramowitz, and Michael P. Burkart. 1976. "Election Outcomes: Whose Money Matters?" *Journal of Politics* 38:1033–38.

Goldenberg, Edie N. and Michael W. Traugott. 1984. *Campaigning for Congress*. Washington, DC: Congressional Quarterly Press.

Goldenberg, Edie N., Michael W. Traugott, and Frank R. Baumgartner. 1986. "Preemptive and Reactive Spending in U.S. House Races." *Political Behavior* 8:3–20.

Green, Donald P., and Jonathan S. Krasno. 1988. "Salvation for the Spendthrift Incumbent: Reestimating the Effects of Campaign Spending in House Elections." *American Journal of Political Science* 32:884–907.

———. 1990. "Rebuttal to Jacobson's 'New Evidence for Old Arguments."'

American Journal of Political Science 34:363–72.

Green, Donald P., James Robins, and Jonathan Krasno. 1991. "Using Polls to Estimate the Effects of Campaign Spending by U.S. House Incumbents." Paper presented at the Annual Meeting of the American Political Science Association, Washington, DC

Grier, Kevin B. 1989. "Campaign Spending and Senate Elections, 1978-84." *Public Choice* 63:201–19.

Guzzetta, S. J. 1981. *The Campaign Manual: A Definitive Study of the Modern Political Campaign Process.* Alexandria, VA: Campaign Publishing Co. Herrnson, Paul. 1990. "Campaign Professionalism and Fund-Raising in Congressional Elections." *Journal of Politics* 54:859–71.

Jacobson, Gary C. 1976. "Practical Consequences of Campaign Finance Reform: An Incumbent Protection Act?" *Public Policy* 24:1–32.

———. 1978. "The Effects of Campaign Spending in Congressional Elections." *American Political Science Review* 72:469–91.

———. 1980. *Money in Congressional Elections.* New Haven: Yale University Press.

———. 1985. "Money and Votes Reconsidered: Congressional Elections, 1972–1982." *Public Choice* 47:7–62.

———. 1987. *The Politics of Congressional Elections.* 2d ed. Boston: Little, Brown.

———. 1990. "The Effects of Campaign Spending in House Elections: New Evidence for Old Arguments." *American Journal of Political Science* 34:334–62.

Johnston, J. 1984. *Econometric Methods.* New York: McGraw-Hill.

Jones, Ruth, and Warren Miller. 1985. "Financing Campaigns: Macro Level Innovation and Micro Level Response." *Western Political Quarterly* 38:187–210.

Judge, George C., R. Carter Hill, William E. Griffiths, Helmut Lutkepohl, and Tsoung-Chao Lee. 1988. *Introduction to the Theory and Practice of Econometrics.* 2d ed. New York: John Wiley and Sons.

Kenny, Christopher, and Michael McBurnett. 1992. "A Dynamic Model of the Effect of Campaign Spending on Congressional Vote Choice." *American Journal of Political Science* 36:923–37.

Kessel, John. 1992. *Presidential Campaign Politics.* 4th ed. Homewood, IL: Dorsey Press.

Krasno, Jonathan S., Donald P. Green, and Jonathan A. Cowden. 1994. "The Dynamics of Campaign Fundraising in House Elections." *Journal of Politics* 56:459–74.

Magleby, David B., and Candice J. Nelson. 1990. *The Money Chase: Congressional Campaign Finance Reform.* Washington, DC: Brookings Institution.

Maisel, Louis Sandy. 1986. *From Obscurity to Oblivion: Running in the Congressional Primary.* 2d ed. Knoxville: University of Tennessee Press.

Malbin, Michael J. 1984. *Money and Politics in the United States: Financing*

Elections in the 1980s. Washington, DC: American Enterprise Institute.

Mann, Thomas E., and Raymond E. Wolfinger. 1980. "Candidates and Parties in Congressional Elections." *American Political Science Review* 74:617–32.

Ragsdale, Lyn, and T. E. Cook. 1987. "Representatives' Actions and Challengers' Reactions: Limits to Candidate Connections in the House." *American Journal of Political Science* 31:45–81.

Salmore, Barbara G., and Stephen A. Salmore. 1989. *Candidates, Parties, and Campaigns: Electoral Politics in America.* 2d ed. Washington, DC: Congressional Quarterly Press.

Scammon, Richard M., and Alice V. McGillivray, eds. 1991. *America Votes.* Washington, DC: Congressional Quarterly Press.

Silberman, Jonathan, and Gilbert Yochum. 1978. "The Role of Money in Determining Election Outcomes." *Social Science Quarterly* 58: 671-82.

Stewart, Charles, III. 1989. "A Sequential Model of U.S. Senate Elections." *Legislative Studies Quarterly* 14: 567–601.

Thomas, Scott J. 1989. "Do Incumbent Campaign Expenditures Matter?" *Journal of Politics* 51:965–76.

Wilcox, Clyde. 1987. "Timing of Strategic Decisions: Candidacy Decisions in 1982 and 1984." *Legislative Studies Quarterly* 12:565–72.